# What's the point? Impact of Ireland's bonus points initiative on student profile in mathematics classrooms

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In 2012 mathematics was assigned a special status within the Irish post-primary school curriculum with the introduction of a bonus points initiative (BPI). Students are now awarded additional credit in their upper post-primary school state examination results if they achieve a passing grade in mathematics at higher level. This extra credit will increase the likelihood of these students securing a place on the third-level course of their choice. This incentive was introduced to encourage students to study mathematics at higher level. Anecdotally there have been mixed reviews about the success of the BPI. While the numbers taking higher level mathematics have increased steadily, there have been concerns that many students who are not capable of performing up to the standard required are now opting for the higher level paper and the difficulty of this examination and the marking schemes have been adjusted accordingly. This paper reports on a national study, the first of its kind, that was conducted to investigate teachers' perspectives (N = 266) on the BPI. The authors investigate if the increase in the number of students studying higher level mathematics in Ireland has occurred in tandem with an increase in the mathematical proficiency of students and they ascertain the impact of the BPI on the profile of higher level mathematics classes.

## Introduction

The benefits of studying advanced or higher level mathematics, henceforth referred to as higher level mathematics, have been well documented in the literature. According to Chinnappan, Dinham, Herrington and Scott (2008), higher level mathematics facilitates the development of a variety of skills that underpin a scientifically literate workforce. The work of Ker (2013) offered support to this argument as he asserted that mathematics equips students with inter-disciplinary knowledge which is necessary for other STEM subjects, while Watt and Goos (2017) also identified mathematics as an enabling subject for other STEM disciplines. Kennedy, Lyons and Quinn (2014, p. 35) added that higher level mathematics courses in high school are critical if we are to produce graduates who are capable and confident in making informed decisions about "…issues such as renewable energy production… or climate change". Furthermore, research from Hine, Anderton and Joyce (2015) exposed a correlation between the level of mathematical knowledge acquired at second level and student's future success at university. Unsurprisingly, Wolf (2002) found that mathematics is the only A-level subject in the UK that positively influences one's potential future earnings. Many researchers also hypothesised that there is a correlation between participation rates in higher level mathematics and participation rates in other science subjects such as physics (Chinnappan et al., 2007; Kennedy et al., 2014; Ker, 2013). This is also a cause of concern due to the low participation rates reported in physics in the Western world (DeWitt, Archer & Moote, 2019).

## Literature review

Despite the importance of mathematics and the necessity for a mathematically literate workforce for economic growth and personal advancement, many countries worldwide report low numbers of students studying higher level mathematics at upper post-primary level. In Australia, Goodrum, Druhan and Abbs (2012) found that all high school science subjects, mathematics included, were experiencing dramatic declines. Kennedy, Lyons & Quinn (2014) believed that for the subject of mathematics this decline commenced in the 1990s and has continued since in most states. Wilson and Mack (2014) also tried to quantify this problem in New South Wales and they found that the number of students not studying any form of mathematics at upper post-primary level had trebled between 2001 and 2013. Furthermore, the Mathematical Association of New South Wales found that 51% of teachers believed that students who had the capability of studying mathematics at higher level in upper post-primary school were opting not to, and rather were selecting to study mathematics in a more diluted form. Similarly, in the UK participation in higher level mathematics, that is mathematics post-GCSE level (age 16), has been a cause of concern for many years. According to Noyes (2013) only 10-15% of 16-year-old students choose to continue their study of mathematics and he reported that this figure is low when compared with other developed countries.

Similar problems have been reported internationally, in the USA (National Commission on Mathematics and Science Teaching, 2000); India (Garg & Gupta, 2003); and France (Charbonnier & Vayssettes, 2009). In Ireland, mathematics is not strictly a compulsory subject at upper post-primary level, however it is treated as such by schools since it is a gatekeeper for the vast majority of third-level courses. Thus, studying mathematics for Senior Cycle[1] is typically expected of all students and this is reflected in the numbers studying mathematics each year (SEC, 2018). However, a cause for concern in Ireland for many years is the low number of students who opt to study the most advanced form of mathematics at upper post-primary level.

Many reasons have been cited in the literature for the low uptake of higher level mathematics. For example, Nagy et al. (2010) found that students' perceived competence can influence their decision to study higher level mathematics while Hine (2019) cited students' dissatisfaction with mathematics as a primary cause for low uptake. Students' social circles, including parents and siblings, have also been found to influence student choice (Joensen & Nielsen, 2018; Kirkham, Chapman & Wildy, 2020), while the

[1] In Ireland, post-primary education is divided into two cycles. *Junior Cycle* is made up of the first three years of post-primary education when students are aged between 12/13 and 15/16. *Senior Cycle* is a two year cycle that follows the Junior Cycle, with an optional "gap year", known locally as *Transition Year*, offered to students between Junior and Senior Cycle.

phenomenon of out-of-field teaching, an issue prevalent worldwide (Ní Riordáin & Hannigan, 2009; Mc Conney & Price, 2009, Bosse & Törner 2012), has also been proposed as a potential reason for low numbers of students enrolling in higher level mathematics worldwide (Chinnapen et al., 2007; Easey, 2019).

However, across much of the literature one cause seems to dominate and that is related to the perceived difficulty of higher level mathematics and the additional time and effort required to succeed in the subject without any additional reward. Many students feel there is a mismatch between the effort required to succeed at higher level mathematics and the reward offered for success (Hine, 2019). For example, almost half of the students (42.9%) in a study conducted by Hine (2019: 304) cited that higher level mathematics courses are too challenging due to "...the amount of content [to be studied] and the pace at which this content is delivered". Similar issues regarding the overcrowded curriculum and the lack of time available to study higher level mathematics at upper post-primary school were also reported in Ireland by O'Meara and Prendergast (2019). Researchers have also found that the time and effort required for higher level mathematics leads some students to believe that studying mathematics in its most advanced form will detract from the time available to study other subjects (Chen & Liu, 2009; Hine, 2019). Hence, in order to maximise the total score attained in high stake exams across multiple subjects, students often choose strategically to study mathematics in a less advanced form and concentrate their time and effort on improving their scores in other subjects that they deem less difficult (Kirkham, Chapman & Wildy, 2020).

Regardless of the reasons, the low uptake of higher level mathematics internationally is a cause for concern due to the number of associated, knock-on effects. For example, low uptake of higher level mathematics is resulting in lower numbers of students studying mathematics at third level internationally (Holten et al., 2009) while students entering other non-mathematics undergraduate programs, which have some mathematical modules, do not have the requisite mathematical knowledge to succeed (Poladian & Nicholas, 2013; Wilson, Mack & Walsh, 2013). This in turn is having a detrimental effect on the standard of graduates entering STEM professions. Hence, due to both the importance of higher level mathematics, the issues in relation to uptake that the authors have just discussed, and the knock-on effect of such issues it is unsurprising that improving mathematics participation and achievement at upper post-primary level is an area of considerable focus amongst education systems and policy makers worldwide (Hine, 2019; Hodgen, Foster, Marks & Brown, 2018; Easey & Gleeson, 2016; Noyes, 2013). According to Brown, Brown and Bibby (2008, p.3), "Improving participation rates in specialist mathematics after the subject ceases to be compulsory at age 16 is part of government policy in England". Internationally, although advocated for, it appears as though very few policies or strategies have been introduced to increase participation rates in higher level mathematics. Noyes (2013) outlined how there is currently very little consensus about how to tackle the issue of low participation rates in certain subjects.

However, one initiative which has been introduced is a bonus points system in the state of Queensland, Australia. This initiative recognises the additional time and effort required for higher level mathematics and rewards students with extra credit for studying and passing higher level mathematics at upper post-primary level (Jennings, 2014). This additional credit will help to improve students' overall score in the exams taken at the end of upper post-primary education and hence could possibly increase the number of third-level programs available to these students. Initial research into this initiative seems to suggest it has helped to reverse the trend of declining numbers studying higher level mathematics in Queensland (Queensland Curriculum and Assessment Authority, 2015) but very few other findings in relation to the effectiveness of this initiative have yet to be published. In recent years, Ireland has adopted a very similar policy to that in place in Queensland and it is hoped that this initiative will address the shortage of students studying higher level mathematics.

Prior to 2012, the typical proportion of students studying higher level mathematics in their final two years of secondary schooling in Ireland was 15.8%. In 2012, the Government of Ireland introduced the *Bonus Points Initiative* (BPI), which sought to encourage more students to opt to study mathematics at higher level for Senior Cycle (Treacy, 2018). In Ireland, students must sit a summative examination, known as the Leaving Certificate, at the end of upper post-primary school. The Leaving Certificate acts as a gatekeeper to tertiary education with students awarded points based on their six best subjects. Prior to 2012, the maximum points that could be awarded for the top grade in a subject studied in its most advanced form (higher level) was 100. Since 2012, mathematics has been assigned a special status within Irish schools with the introduction of the BPI. Students are now awarded an additional 25 points if they achieve a pass grade at higher level (≥ 40%) in their mathematics Leaving Certificate examination.

As mentioned previously, many people have cited that the perceived level of difficulty is one of the principal causes for poor uptake of higher level mathematics (Hine, 2019; Kirkham, Chapman & Wildy, 2020; Brown et al., 2008) and the additional points offered is seen as a way of acknowledging the level of difficulty associated with higher level mathematics, while simultaneously increasing the uptake of higher level mathematics. The DES (2017) are now considering expanding this initiative to other subjects but prior to this the authors believe it is critical that the BPI is critiqued. This paper will present findings in relation to teachers' perspectives on the BPI and the impact it has had on the profile of higher level mathematics classes and students' proficiency in mathematics.

## Context

### Post-primary education: An overview

In Ireland, students enter post-primary education aged 12 or 13. Post-primary education consists of two cycles, known locally as Junior and Senior Cycle. Junior Cycle is compulsory for all Irish students and consists of 1st, 2nd and 3rd year. There are 28 subjects available for students to study at Junior Cycle and students must study a minimum of ten. At Junior Cycle, mathematics must be one of the ten subjects studied. At the end of the third year, students must sit a summative state examination in all their chosen subjects, known locally as the Junior Certificate. Students then progress from Junior Cycle to Transition Year or Senior Cycle at the age of 15 or 16. Transition Year is an optional year of study available to students in a large proportion (81%) of post-primary schools (Prendergast & O'Meara, 2016). It is a non-academic 'gap' year which seeks to promote students' social and personal development (Clerkin, 2012). If students choose not to partake in Transition Year, they progress straight to Senior Cycle (otherwise they progress to Senior Cycle on completion of Transition Year). Senior Cycle is a two-year cycle consisting of 5th and 6th year. In Senior Cycle students must study the subject of Irish and select a minimum of four other subjects. Again, at the end of this two-year cycle students must sit a State Examination in all their subjects, known locally as the Leaving Certificate. Results in this State Examination dictates the tertiary course that a student can enrol in upon graduation from post-primary education. The grading points system currently in place, which acts as a gatekeeper to tertiary education, encourages students to study between six and eight subjects.

## Mathematics at post-primary level

Post-primary mathematics education in Ireland has experienced substantial changes in the past decade. In 2010 a new curriculum, entitled 'Project Maths', was introduced on a phased basis at both Junior and Senior Cycle. The aim of the new curriculum is to teach mathematics in a way that promotes deep understanding among students (Department of Education and Skills, 2010). This reform advocated a change in the mathematics content to be taught, the way in which it was taught and the manner in which it was assessed. Hence, findings presented in this paper will need to be considered in light of these curriculum changes as well as the introduction of the BPI.

One aspect of the curriculum that did not change was the levels at which students could choose to study mathematics. Students can choose three levels for their Leaving Certificate mathematics state examination – foundation level; ordinary-level and higher level. Higher level is the most advanced form of mathematics that students can study at Senior Cycle. Ordinary level is the next level down. Ordinary level covers many of the same concepts addressed at higher level but not to the same level of detail. Also, some topics such as integral calculus and hypothesis testing appear in the higher level course but not the ordinary level course. Foundation level is designed for people who struggle with ordinary level and it covers basic mathematical skills.

Mathematics is not a compulsory subject at Senior Cycle, however, due in part to the matriculation requirements of Irish Higher Education institutes, virtually all Irish students study mathematics for the Leaving Certificate. This is reflected in annual statistics released by the State Examinations Commission (SEC). For example, in June 2019, 56,071 students sat the Leaving Certificate and 55,094 (98.26%) of these students sat a mathematics examination. Given that the uptake of mathematics at post-primary level does not present a significant challenge, increasing the number of students studying mathematics in its most advanced form, i.e. higher level, was considered, by policy makers, to be a potential strategy for improving the uptake of higher level mathematics and in turn students' attainment in mathematics. This was the motivation behind a significant policy change that was introduced in 2012, known locally as the *Bonus Points Initiative*.

## The Bonus Point Initiative [BPI]

In Ireland, the Leaving Certificate exam acts as a gatekeeper to tertiary education. Students are awarded points based on the result they obtain in each subject and the number of points awarded varies depending on whether the subject is studied at higher or ordinary level (no points are awarded for studying a subject at foundation level). The breakdown of points awarded for each grade at both levels is depicted in Table 1.

Table 1: Points awarded for grades achieved in Leaving Certificate examinations

| Examination score | Higher level | | Ordinary level | |
|---|---|---|---|---|
| | Grade | Points awarded | Grade | Points awarded |
| 100% - 90% | H1 | 100 | O1 | 56 |
| 89% - 80% | H2 | 88 | O2 | 46 |
| 79% - 70% | H3 | 77 | O3 | 37 |
| 69% - 60% | H4 | 66 | O4 | 28 |
| 59% - 50% | H5 | 56 | O5 | 20 |
| 49% - 40% | H6 | 46 | O6 | 12 |
| 39% - 30% | H7 | 37 | O7 | 0 |
| 29% - 0% | H8 | 0 | O8 | 0 |

The points for students' six best subjects are then tallied and the total number of points accumulated is key in determining the third level courses to which students can be admitted.

In 2011 the proportion of students studying higher level mathematics in their final two years of post-primary education was 15.8%. This was compared to 63.71% studying higher level English; 32.33% studying higher level Irish; 73.39% studying higher level physics and 81.7% studying higher level chemistry that year. In 2012 the Bonus Points Initiative [BPI] was introduced thus assigning mathematics with a unique and special status in post-primary schools. The BPI sought to encourage a larger proportion of students to study higher level mathematics at Senior Cycle (Treacy, 2018) and remains in place today. This initiative awards students who achieve a passing grade (H6 or higher) in the higher level Leaving Certificate mathematics examination an additional 25 points. That means, for example, a student who achieves a H4 grade (60% - 69%) would now receive 91 points (66 + 25) in mathematics but 66 points for achieving the same grade in any of their other subjects. As a result of the BPI, there are now 125 points available to students who study mathematics at higher level compared to the 100 points available for studying any of the other 33 Senior Cycle subjects in their most advanced form. The BPI has also resulted in the maximum number of points a student can acquire increasing from 600 (pre-2012) to 625.

While the primary motivation behind the introduction of the BPI was to increase the number of students studying higher level mathematics, the additional 25 points awarded is also seen as a way of acknowledging the time demands of the higher level mathematics course and the perceived level of difficulty of the course. The perceived level of difficulty of mathematics is cited as one of the main reasons for poor uptake of higher level mathematics (Brown et al., 2018) while concern has long been expressed over the workload and timeframe of the Leaving Certificate higher level curriculum (Cosgrove, Perkins, Shiel, Fish & McGuinness, 2012; O'Meara & Prendergast, 2019; Prendergast & Treacy, 2018). Both of these factors have often deterred students from pursing the subject at its highest level and the additional points offered under the BPI is seen as a way of counteracting these difficulties associated with higher level mathematics. It is therefore hoped that with the BPI in place a much higher proportion of students would study mathematics in its most advanced form and the mathematical competencies of Irish second-level graduates would simultaneously increase.

## Research questions

Following on from the extensive literature review, the authors derived the following research questions that will underpin this study:

1. Has the BPI achieved its goal of (a) increasing participation in higher level mathematics and (b) enhancing students' mathematical performance?
2. What impact has the BPI had on student profile in higher level mathematics classes and what is the potential reason for any change in profile?

## Method

### Research instrument

In order to address the aforementioned research questions the authors first analysed data released by the Irish State Examinations Commission. They then proceeded to employ survey research to ascertain teachers' perspectives on the impact of the BPI on student profile in higher level mathematics classes. For this study, it was important to get a high response rate and the authors felt that the response rate would be increased if they used an instrument that would be easy to distribute and collect and one that the participants did not find too time consuming to complete. As a result, the research design involved the distribution of a questionnaire to a representative sample of senior cycle teachers in Ireland. The questionnaire designed for this study allowed the research team to gather both quantitative and qualitative data. A Teacher Research Advisory Group (TRAG) was established to assist with the design of the questionnaire. The TRAG consisted of five teachers and all members of this group were experienced in their positions and were recruited using a purposive sampling method. Members of the TRAG were invited to participate on the basis of the expertise they could bring to the research and the contemporary issues they have in similar peer groups to the research participants.

Following the design of the first draft of the questionnaire, members of the TRAG were invited to provide feedback and to refine the questionnaire items. The TRAG recommended that the research instrument should not exceed four pages and advised that open-ended questions should also be included in the questionnaire so as to allow teachers to provide qualitative feedback in relation to their perspectives on the BPI. Furthermore the TRAG advised that the questionnaire be anonymised. Members of the TRAG believed that anonymisation would increase the response rate and would encourage teachers to be more honest in their responses. This is in line with recommendations by Cohen, Manion and Morrison (2007). All advice offered by the TRAG was incorporated by the authors when redrafting the final version of the questionnaire, which contained seventeen items in total (Table 2).

Table 2: Questionnaire description

| Quest. nos. | Focus | Paradigm | Type of question |
|---|---|---|---|
| 1 - 5 | Demographics | Mixed | Open-ended with numerical values and dichotomous |
| 6 | School policy for class groupings | Qualitative | Open-ended |
| 7 - 8 | Impact of BPI on teaching approaches and student profile | Qualitative | Open-ended |
| 9 - 11 | Impact of BPI on uptake and performance | Mixed | Multiple choice with open-ended follow-up |
| 12 | Teachers' perspectives of changing student profile | Quantitative | 5 point Likert scale (1= strongly disagree; 5=strongly agree) |
| 13 | Teachers' vision for the future of the BPI | Qualitative | Open-ended |
| 14 - 15 | Teachers' perspectives on advantages and disadvantages of BPI | Qualitative | Open-ended |
| 16 | Teachers' view on BPI | Mixed | Multiple choice with open-ended follow-up |
| 17 | Additional comments | Qualitative | Open-ended |

This article will focus on items that relate to student profile, changes in student performance, and policies in place for selecting students eligible for higher level mathematics at Senior Cycle (Questions 6, 9, 10, 11 and 12).

## Sample

The sampling frame for the study was a list of all 723 post-primary schools in Ireland (DES website, February 2015) and the targeted sample size for this study was 800 teachers. In order to identify a random sample, stratified sampling was used. The strata employed in this selection process related to school type. In Ireland there are four post-primary school types – 11.1% of schools are community schools, 35% are vocational schools, 1.9% are comprehensive schools and the remaining 52% are secondary schools. Members of the TRAG advised that, on average, there are two higher level mathematics teachers employed in post-primary schools and so a stratified random sample of 400 schools was selected: 44 schools (11.1%) were community schools; 140 (35%) were vocational schools; 8 schools (1.9%) were comprehensive schools and 208 (52%) were secondary schools[2]. In total, 266 teachers returned completed surveys, a response rate of 33.3%, which exceeds the 20% - 30% range recommended by Veal and Flinders (2001) for mailed surveys. While such a response rate for questionnaires is considered good, the motivation behind a teacher's decision to respond needs to be considered. It may be the case that they were motivated due to the holding of strong opinions on the topic and this needs to be taken into account when considering the findings outlined in this paper.

### Research design and data analysis

The questionnaires were distributed in April 2018 via post and were addressed to the Head of Mathematics at each school. It was requested in the accompanying information sheet that the two copies of the questionnaire enclosed should be completed by two teachers of higher level, Senior Cycle mathematics in the school and returned in the stamped addressed envelope provided. The quantitative data gathered via the questionnaire was recorded, summarised and analysed using the computer package *SPSS*. The open-ended questionnaire responses were transcribed and analysed using *NVivo*. The authors employed thematic content analysis when analysing this data. A coding scheme was generated based on a mixed deductive and inductive approach. On the one hand, codes were derived theoretically, taking into account the research questions, the literature review and the results emanating from the quantitative analysis. On the other hand, themes were identified from the open-ended questions, providing the basis for generating new codes or modifying the existing codes. The coding allocated by each researcher was then compared and any discrepancies were discussed and resolved by the authors, in order to provide sound and consistent interpretation of the data, before the coding scheme was finalised.

## Results

### Research question 1

In order to address the first research question, the research team first analysed statistics released by the State Examinations Commission [SEC] to determine the impact, if any, that the BPI had on the numbers studying higher level mathematics and on students' mathematical performance. As shown in Figure 1, in the year that the BPI was introduced there was a noted leap in the proportion of students studying higher level mathematics, from 15.8% in 2011 to 22.1% in 2012 and this proportion has continued to rise year on year, reaching 32.9% in 2019.

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[2] In Ireland, secondary schools are privately owned and managed. They are under the trusteeship of religious communities, boards of governors or individuals. Vocational schools are owned and run by local Education Training Boards while comprehensive and community schools are managed by boards of management which are representative of local interests. The schools are financed entirely by the Department of Education and Skills.

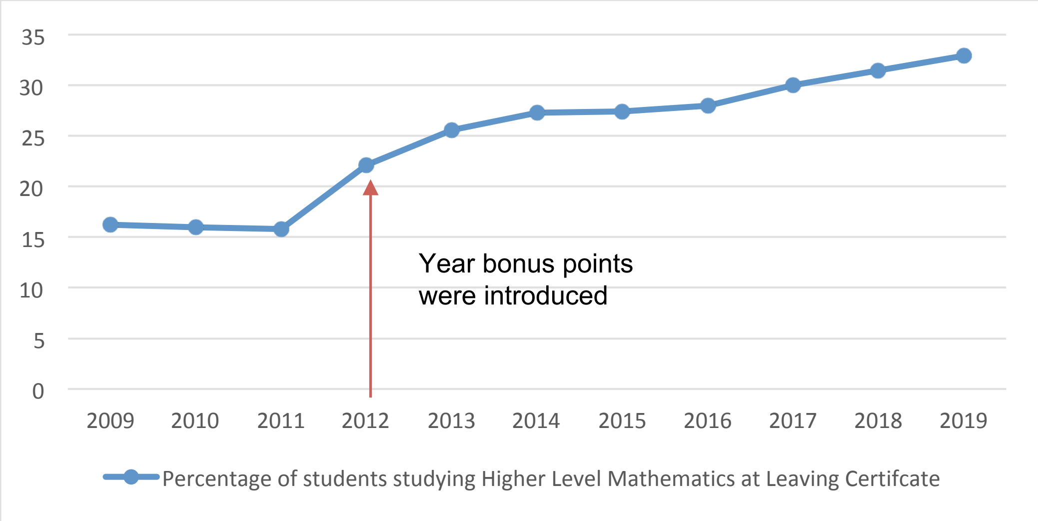


Figure 1: Change in the proportion of students studying higher level mathematics since the introduction of the BPI

Improvements in students' mathematical capabilities was also the focus of the first research question as it too was a goal of the BPI when it was introduced in 2012. SEC data was again used by the research team to determine if there was a notable difference in students' performance in the two mathematics State Examinations (Junior Certificate and Leaving Certificate) before and after the BPI was introduced. The findings are presented in Figure 2.

Figure 2 first indicates that the increase in the number of students studying higher level at upper post-primary level, as reported in Figure 1, is not as a result of improved performance in the Junior Certificate examination. Between 2009 and 2019 there was a slight increase in the number of students achieving in excess of 70% in the Junior Certificate mathematics examination, thus suggesting that after 2012 students were not entering Senior Cycle with a much stronger understanding of mathematics than was the case prior to 2012. The second story that emerges from Figure 2 is the fact that the introduction of the BPI has not led to the desired increase in mathematical proficiency among the majority of students upon graduation from post-primary school. Since the BPI was introduced in 2012 the number of students who achieved in excess of 70% in the Leaving Certificate rose from 3895 to 6190, an increase of 2295.

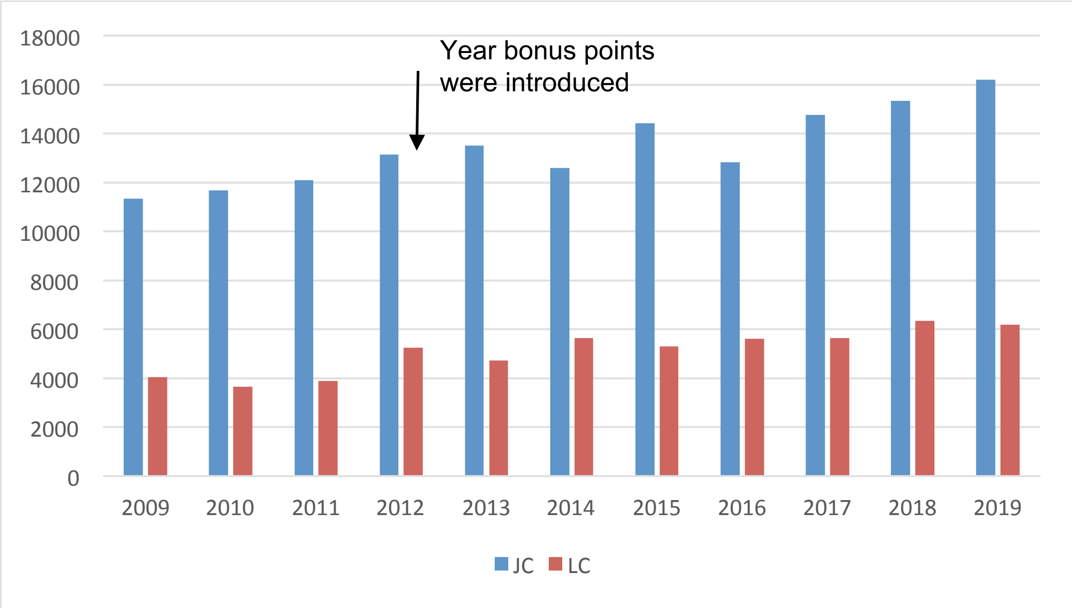


Figure 2: Number of students receiving >70% in Junior and Leaving Certificate exams between 2009 and 2019

However, it is worth noting that while the percentage increase in the number of students studying higher level mathematics in this timeframe stood at 120.4%, the corresponding percentage increase in the number of students obtaining in excess of 70% was much smaller, standing at 58.9%. Further analysis of these statistics shows that, between 2011 and 2019 there was a notable decrease, from 47.3% to 34.1%, in the proportion of students obtaining 70% or more in this examination, with the biggest annual drop recorded between 2012 (47.1%) and 2013 (36.3%). This was in the immediate aftermath of the introduction of the BPI. As a result, while Figure 1 indicates that the first goal of the BPI, increasing the number of students participating in higher level mathematics, has been achieved, Figure 2 highlights that the second goal relating to improving students' mathematical competencies still requires much work and the BPI might not be the ideal solution to this particular problem.

Once this analysis of SEC data was complete, the research team analysed the survey responses in an attempt to unveil the impact that the BPI had on these statistics. Teachers were first asked what they believed were the reasons behind the increase in the proportion of students studying higher level mathematics, bearing in mind that a number of different changes to mathematics education in Ireland had occurred in this timeframe. They could choose from the following list:

- The introduction of Project Maths;
- The introduction of the BPI;
- Not sure;
- Other (please specify).

The majority of teachers in this study (91.4%) were unequivocal in their assertion that the BPI was the sole reason for the increased uptake of higher level mathematics at both Junior and Senior Cycle. Given this finding in relation to the perceived influence of the BPI on the uptake of higher level mathematics, the authors were also keen to investigate whether teachers believed there was a corresponding improvement in students' mathematical aptitude. In the survey teachers were asked if they believed that the goal of raising mathematical standards among students in their school had been achieved and the results are presented in Figure 3.

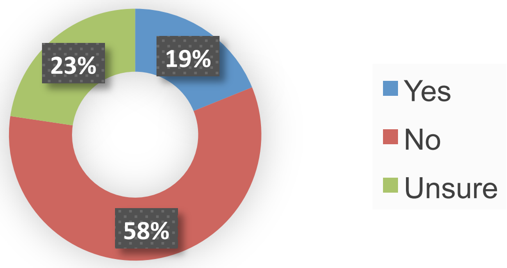


Figure 3: Teachers' perceptions in relation to the BPI improving mathematical standards

In total 265 teachers responded to this survey item with a small number (n = 50) reporting that they saw an improvement in students' mathematical capabilities. Instead the majority of teachers (n = 155) reported that, despite the significant rise in the number of students studying mathematics in its most advanced form, they did not believe that there was a corresponding improvement in students' mathematical ability. Instead, the following quotes from teachers indicate how they felt the BPI had a negative impact on many students' proficiency in the subject.

> T191: It is great to see more students taking higher level maths but the standard of ability is not good.
>
> T273: They are so lost now at higher level they are learning nothing at all whereas in ordinary level they would gain a better understanding of the key concepts.
>
> T391: As explained above many of the students taking higher level who might not have done so previously find the material and the pace at which material is covered too difficult. They often now have a poorer understanding of even ordinary level topics than students in ordinary level classes..
>
> T267: As there are more students completing LC [Leaving Certificate Mathematics] exams, the marking scheme has to be adjusted to cater for the weaker students.

### Research question 2

The second research question underpinning this study focused on the impact of the BPI on the student profile in higher level mathematics classes. In order to address this research question the authors had to analyse both quantitative and qualitative data. First, the authors conducted a thematic analysis on the responses offered by teachers to the open-ended question 'What impact (if any) has the Bonus Points Initiative had on the student profile of your Senior Cycle mathematics groupings?" All 266 teachers in the study offered a response to this question and the majority believed that the BPI had a significant impact on the student profile in their classroom with only 8 teachers (3.0%) reporting that the BPI had no impact on the student profile in their classroom. The most common change to profile reported by teachers was that the BPI resulted in people not suited to higher level mathematics now persevering with it, to the detriment of some.

> T152: Higher numbers trying higher [level] though [they] are not at all suited and many of these struggle from the outset.
>
> T391: More of the students who struggle with higher level mathematics stay and do the exam. They stay purely to earn bonus points. Many stay who would be better served at ordinary level. Our failure rate has increased at higher level because of this.
>
> T168: Bonus points have encouraged more students to try higher level maths which is great. However, some of the students deciding to do higher level do not have the required standard of maths to enable them to do so. It is putting enormous pressure on teachers.

A total of 81 teachers (30.5%) alluded to this type of change in student profile. This finding was echoed in the quantitative data when 266 teachers ranked their level of agreement with the statement "Many students who are struggling at higher level persist due to the provision of Bonus Points.". The findings to emerge from this question are presented in Figure 4.

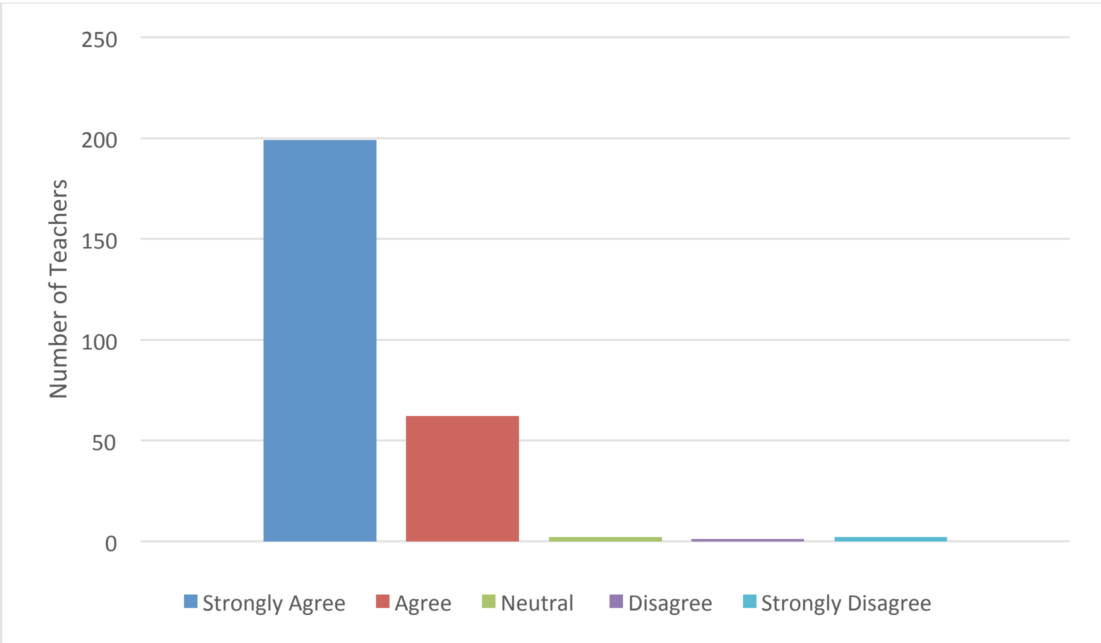


Figure 4: Teachers' responses to the statement "Many students who are struggling at higher level persist due to the provision of Bonus Points."

Figure 4 clearly reiterates the points raised by teachers in response to the open-ended question relating to the change in student profile. Only 3 teachers surveyed disagreed or strongly disagreed that struggling students are persisting with higher level mathematics while 261 teachers agreed with this statement, with the vast majority (n = 199) strongly agreeing. This feeling was also reiterated by some teachers when asked at the end of the survey to outline any other comments they had in relation to the BPI. A large proportion of teachers who responded to this question offered responses suggesting that students are now only pursuing higher level as a result of the BPI and persist with it despite encountering many struggles. The following is an example of responses of this nature:

> T116: Students who would not attempt higher level only because of the extra points tend to be lost on the concepts and focus on rote learning.

One possible reason for this change in profile that has come about as a result of the BPI relates to the policies employed in schools to identify students who should be studying higher level mathematics for the Senior Cycle. In this study teachers were asked to describe the policy, if any, that is employed in their school to identify the students who are allowed to progress to higher level mathematics at Senior Cycle. All 266 teachers outlined the policy in place in their school with a total of 12 different policies being described. The most popular policy, described by 96 teachers (36.1%), was that their school allowed the students to make the decision regarding what level they wished to study for Senior Cycle. Of the 96 responses that fit under this theme, 35 stated that while the decision is completely left to students and/or their parents, teachers also offer strong recommendations. However, these recommendations cannot be enforced but rather offer some guidance to students. Sample responses from this theme include:

> T69: Any student who wishes to do higher level is accommodated.
> T94: Everyone is given the opportunity, currently under review due to number dropping/failing.
> T263: Any pupils who want to do HL [higher level] have the opportunity to do so.
> T55: Generally, any student wishing to take higher level is allowed progress. Teacher will advise student but cannot prevent student from taking whatever level they wish.

Such feedback from teachers suggests that in a large number of schools students are free to choose the level that they study mathematics at for Senior Cycle, regardless of prior performance or the level they have studied up until that point. However, as pointed out by one teacher (T94) this is not always seen as the ideal policy and can lead to a high drop-out and failure rate. This finding could help to explain why there has been a significant increase in the number of unsuitable candidates studying higher level mathematics as reported by teachers in this study.

Another change in student profile, possibly a direct consequence of previous findings, reported by a number of teachers (n = 61) was in relation to more mixed ability classes. The large number of less able students doing higher level mathematics has resulted in a much wider range of abilities than would have been the case prior to 2012.

T431: The range in abilities is far too great. There are students attempting [higher level] for the sake of trying to achieve more points, when they are simply not capable and end up doing poorly in their exams.

T52: More students are doing HL and remaining in higher level despite the lack of progress in some cases. The average ability of HL students has decreased.

The change in student profile, suggested by these responses, presents teachers with a series of new challenges to contend with, most notably in terms of catering for much higher levels of diversity in the mathematics classroom. This issue relating to mixed ability is further exacerbated by students persisting with higher level mathematics for a longer period of time, before dropping to ordinary level. This finding was unearthed when teachers were asked at what point in the Senior Cycle were students most likely to drop from higher to ordinary level. The findings are presented in Figure 5.

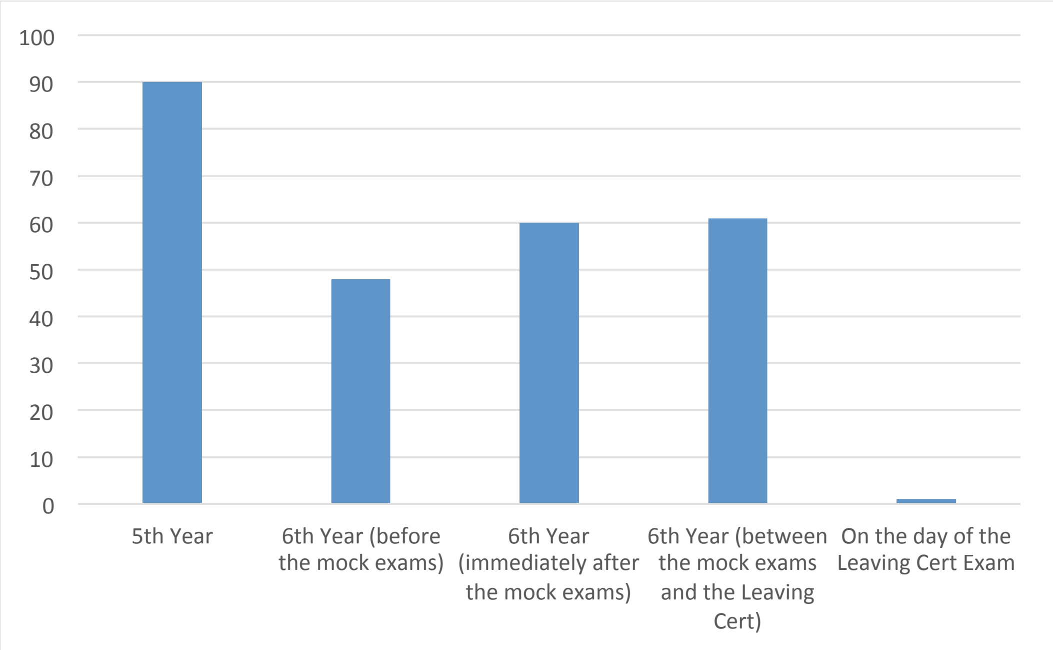


Figure 5: Teachers responses when asked when the majority of their students who drop to Ordinary Level make this decision

Figure 5 shows that while a substantial number of teachers (n = 90) reported that students drop from higher to ordinary level in the first year of Senior Cycle, the majority of teachers (n = 121) ascertain that most of their students drop to ordinary level in the three months prior to the Leaving Certificate, once the mock examinations[3] results have been

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[3] Mock examinations are practice examinations that sixth-year students take in early spring [mid-February]. These are modelled on the State Examinations, which students are required to sit at the end of Senior Cycle and are seen as a mechanism to prepare students for these State Examinations (O'Meara & Prendergast, 2017).

released. This suggests that while there has been a 17.1% increase in the number of students sitting the higher level paper between 2011 and 2019, there has been a much steeper increase in the number of students sitting in higher level classes for the majority of the Senior Cycle, thus exacerbating issues relating to the diverse range of abilities in higher level mathematics classes. The impact of the BPI on this issue was further confirmed by teachers when asked if they believed that this initiative was leading to students making this critical decision to drop from higher to ordinary level later than was the case pre-2012.

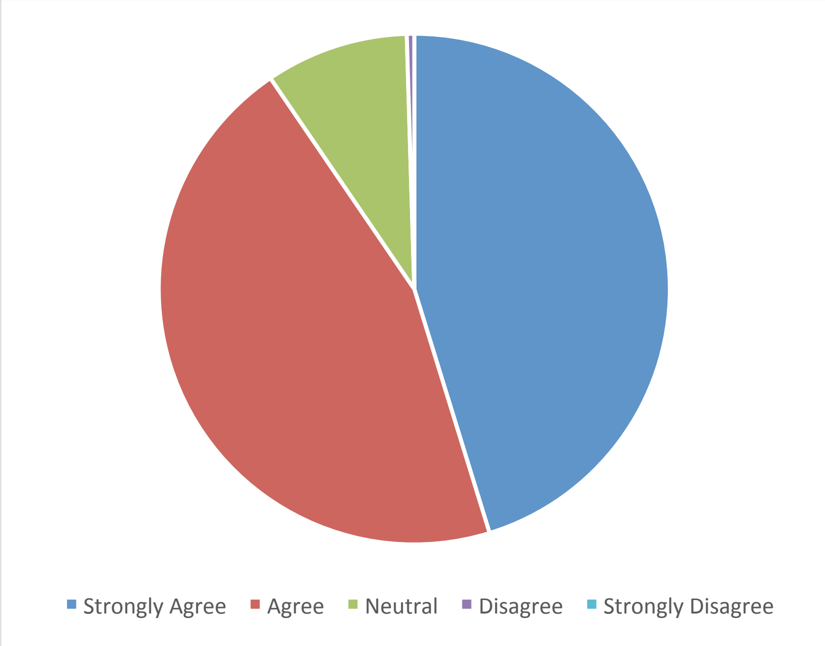


Figure 6: Teachers responses when if they believed students who drop from Higher to Ordinary Level are doing so later in Senior Cycle than was the case before the BPI

In total 263 teachers responded to this question and Figure 6 shows that the vast majority of teachers (n = 230) agreed or strongly agreed that the BPI led to students dropping from higher to ordinary level later in the cycle. This again suggests that the range of abilities in higher level mathematics classes has been significantly impacted and now, as a result of BPI, a more diverse cohort of students are studying higher level mathematics for a more prolonged period of time.

Finally, another change in student profile reported by teachers relates to less ambitious students now selecting higher level mathematics. 35 teachers reported that students in higher level classes now have lower expectations of themselves with many aiming to just reach, rather than exceed, the score required to be awarded bonus points. Teachers also report that such students are not as hardworking as those that would have selected higher level in the past.

> T383: Students are hanging on at higher level to gain bonus points. A lot of students now have the attitude '40% will do'.

T217: Students who would have taken ordinary level prior to the introduction of BPI are now attempting the higher level paper and are willing to settle for a low grade.

T373: Definitely have a lot more students taking it on, that probably wouldn't have before. You also have a lot of students who hang in there and aren't willing to do the work involved and just try and pass it.

## Discussion

The findings of this study have shown that the BPI has achieved one of its goals, in that it increased the number of Irish students studying higher level mathematics. There has been a significant increase, from 15.8% to 31.5%, in the seven years since the BPI was introduced. On the surface, this may appear to indicate that Ireland has found an incentive, as suggested by Brown et al. (2008) and Smith (2017), to increase participation rates in higher level mathematics. As was the case in Queensland, as reported by the Queensland Curriculum and Assessment Authority (2015), the BPI seems to have reversed the trend of declining numbers opting to study higher level mathematics in Ireland. However, increased participation rates was only one of the aims of the BPI. An additional objective of this initiative was to enhance students' mathematical skills (Treacy, 2018). Many researchers, such as Hodgen et al. (2018), have called for a simultaneous increase in participation and attainment, but this study reveals that while the BPI is successful in the former, it may not be having the desired effect on the latter. Only 18.9% of teachers surveyed believe that the BPI has resulted in an overall improvement in students' mathematical ability, despite many more students studying mathematics in its most advanced form.

This belief is also reinforced when one compares students' results pre and post-BPI. In 2018, 37.7% of higher level students attained 70% or more in their Leaving Certificate mathematics examination, compared with 47.2% in 2011. This is despite many believing that the difficulty level of the Leaving Certificate mathematics examination decreased in this time period (Treacy, 2018). Furthermore, when discussing the introduction of the BPI and its impact on the Leaving Certificate mathematics examination and grading process with experienced upper post-primary examiners, Treacy (2018, p.431) found that they [experienced examiners] "...alluded to the adjustment in marks awarded and difficulty of questions set from 2012 onwards to ensure that a relatively consistent failure rate is maintained." Treacy (2018) concluded that mathematical standards may have been reduced to enable students to achieve a passing grade in the higher level paper in order to keep the failure rate consistent. This could mean that the difference between the proportions achieving above 70%, as discussed in this study, could be even greater if the same standards, that existed pre-2012, were maintained.

One potential cause for this may be that students are assigning their efforts strategically. In Australia, the importance attributed to Australian Tertiary Admission Rank [ATAR] scores for university admission led to students opting not to study higher level mathematics (Kirkham, Chapman & Wildy, 2020). Similarly in Ireland the points system in place means that students are strategic in their subject selection and in the effort they assign to different subjects in an effort to maximise the points obtained. Hence, in this instance it may be the case that students realise that in order to get the bonus points on offer they just need to secure 40% in the Leaving Certificate mathematics exam and hence, as one teacher suggested (T383) students now are of the opinion that "40% will do". Students recognise that obtaining 100% in the ordinary level mathematics paper would secure them 15 less points than if they secured 40% in the higher level paper and so they cling on at all costs in the hope of achieving the latter. This raises the question if the points system is contributing to the issue of unsuitable students pursuing higher level mathematics in Ireland.

Another possible reason for this decline in student performance, unearthed in this study, is that the students now taking mathematics are doing so solely to obtain the 25 additional bonus points and not because of any renewed interest or motivation in the subject. Instead, as reported by teachers in this study, current higher level students are happy to study higher level mathematics without investing the time and effort required to improve their skills or excel in the subject. As such, the authors recommend that a campaign to highlight the importance of mathematics in almost every career and in a multitude of daily tasks is undertaken. Such a campaign would allow these additional students studying higher level mathematics to see the importance of the subject, as discussed by Chinnappan et al. (2007) and Kennedy et al. (2014), and this may in turn provide an incentive to dedicate the time and effort needed to improve their mathematical skillset. This could be one additional step taken to help the BPI achieve both of its intended targets.

Another possible reason for the increase in participation but not in competence may be due to the changing profile of higher level mathematics classes. The research showed that in a large number of schools students can choose what level they wish to study mathematics at in Senior Cycle regardless of the level at which they studied mathematics at in Junior Cycle. Teachers in this study however reported that many students who they deem unsuitable for higher level are now opting for this course of study and as a result, there is a much greater range of abilities in higher level mathematics classes than was the case prior to 2012. According to Linchevski and Kutscher (1998), mathematics is one of the more difficult subjects for working with mixed ability groupings while Hallam and Ireson (2003) suggested that mixed ability grouping is inappropriate for mathematics. The BPI was introduced without any apparent consideration for the impact it may have on class profiles and as such, teachers received no training in dealing with the knock-on effects of the BPI, including guidance on how to develop teaching strategies to cater for more mixed ability classes.

The authors are not proposing that such mixed ability groups have a negative effect on student learning, in fact some studies have shown that such diversity can have a positive impact on student learning (e.g. Davidson & Kroll, 1991). On the other hand, Boaler, William and Brown (2000), and more recently Taylor, Francis, Archer, Hodgen, Pepper, Tereshchenko and Travers (2017), stated that there is not enough conclusive evidence to make a judgement about the impact of mixed ability grouping on student learning.

Instead, the authors argue that a drastic change from more streamed or tracked classes to a mixed ability setting, without any formal training was a very difficult task for teachers and something they are struggling to deal with. Smith (2017) claimed that if we wanted to see meaningful change in the number of students studying higher level mathematics then teachers needed professional development to help to facilitate this. Such professional development is currently not readily available on a wide scale basis in Ireland. As such, the authors recommend that continuous professional development is made available to teachers in the immediate future that focuses on developing the skills needed to teach and assess in mixed ability settings. Such professional development should also precede the introduction of the BPI in any other curricular subject.

## Conclusion

Overall, the authors conclude that while the BPI has been successful in attracting more students to higher level mathematics, such increases in uptake have not occurred in tandem with improvements in students' mathematical ability. Some potential reasons for this have been unearthed in this study, ranging from a lack of effort on the part of students to the increased incidence of mixed ability in mathematics classrooms. However, more research is needed to investigate why a significant improvement in student competencies did not occur in tandem with a marked increase in students studying mathematics in its most advanced form, as reported in this paper. Is this as a result of students strategically opting to do the minimum work required to obtain a pass grade, or are other factors to blame, such as increased class sizes as a result of larger numbers studying higher level? Is it the case that the incidence of out-of-field teaching has increased in Ireland to facilitate the larger numbers studying higher level mathematics? The authors believe these are questions which future studies should seek to investigate in order to develop more insights into the BPI initiative.

There are some limitations to the study. The authors used a stratified random sample of 400 post-primary schools, which was intended to cover 55% of the total number of schools. However, the response rate of 266 teachers across 173 schools means that the findings are drawn from only 24% of Ireland's post-primary school sample. In addition to this, the authors are cognisant of the fact that the 266 teachers who responded all did so voluntarily and this may have led to some bias in the findings presented. These teachers may be the ones who had the strongest opinions regarding the BPI in mathematics and as such the results may be slightly skewed. It is anticipated, however, that the representative nature of the sample in terms of geographical location and school type did help to reduce some of this potential bias. Finally, one must remember that the BPI was introduced in 2012, two years after the phased introduction of a new mathematics curriculum in Ireland began. Despite teachers in this study insisting that the changes noticed in terms of student participation in higher level mathematics was a direct result of the BPI as opposed to the new curriculum, issues unearthed in this study relating to students performance in the Leaving Certificate and teachers struggling with a wider range of ability levels may also be partly linked to both students and teachers adapting to a new curriculum in this time frame.

Despite these limitations, the findings and recommendations proposed in this paper may help to improve students' competency in mathematics and if this was the case, the authors believe that the BPI could be considered a success and used as a model for improving mathematics participation and attainment internationally. However, without some additional changes and revisions the BPI will simply serve to attract students, in an exam-driven system, to study a subject that they do not value and force teachers to engage in teaching styles that they may not be familiar with or have any training in.

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